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# MEASURING PRICES OF MEDICARE PHYSICIAN SERVICES: 1985-1988

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# I. INTRODUCTION

The inclusion of Volume Performance Standards in the Medicare physician payment reform package enacted in the Omnibus Budget Reconciliation Act of 1989 demonstrates the importance many policymakers place on the role of changes in the volume and intensity of services in determining expenditure growth. The general consensus appears to be that controlling fees alone will not be sufficient to control payments. However, understanding the degree to which expenditures have been driven by volume and intensity as opposed to price requires that changes in all of these variables be measured accurately. While price changes for individual services can be measured, there is presently no comprehensive index of price change for all Medicare physician services. A credible set of price indices will allow for the decomposition of the growth in Medicare physician spending, either for all services or for subgroups of services, into its underlying price and volume and intensity components.

Beyond measuring volume and intensity change, there is also a need to explore differences across geographic areas. For example, are the large variations in expenditures per beneficiary that have been documented the result of historical differences in payment rates or the result of real differences in services received? Unless there is a meaningful way to measure aggregate price differences across areas, this question can only be addressed on a procedure-by-procedure basis. A better understanding of variations in volume and intensity is essential if subnational, e.g., state-level, volume performance standards are to be considered. If expenditure differences largely reflect prices, then the current policy that allows volume and intensity to grow at a uniform rate across all areas may seem reasonable. However, if there are large differences in volume and intensity after accounting for price, then it may be

viewed as inequitable to apply the same standards to all areas. Policymakers may want to allow volume and intensity to grow more rapidly in areas that have been below average and less rapidly in above average areas.

In this paper, we develop two types of Medicare price indices. The first can be used to measure price changes over time and is computed for all physician services and for each of the type-of-service categories developed by Berenson and Holahan (1990).[1] Using this index, price change can be measured at the national level or for any geographic area providing the required data, e.g., carriers or large localities. The second index measures cross-sectional differences in price. In this index, prices in each area are compared to national average prices. Again, differentials across all services and for each type-of-service category are derived.

One of the fundamental issues that must be confronted in deriving these indices is that the physician services delivered to Medicare patients and the relative importance of individual services varies dramatically across areas and changes significantly in the span of a very few years. It is for this reason

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1. This type of service classification system divides Medicare services into 4 major categories and 20 subcategories. The first major group is evaluation and management services; it includes office visits, hospital visits, emergency room services, home and nursing home visits, consultations, and specialist evaluation and management services. Specialist evaluation and management services includes a range of evaluation and management services provided by ophthalmologists, psychiatrists, pathologists, allergists, and other subspecialties.

   The second major group is procedures. This includes major procedures, subdivided into cardiovascular, orthopedic, and other, ambulatory procedures which, subdivided into eye and other, and minor procedures,including endoscopies and oncology procedures. Imaging is the third major group and is divided into standard imaging (routine x-rays and nuclear medicine), advanced imaging (CT scans and magnetic resonance imaging), sonographic imaging, and imaging/procedures (largely cardiac catheterization). The final major group is tests, divided into laboratory and other tests. Other tests is dominated by a wide range of cardiovascular tests.

that a price index based on a fixed-weight basket of physician services, such as a Laspeyres price index, can produce substantially biased measures of price. To be reasonably certain that we were aware of the full range of alternative index forms, we contracted with a firm with extensive experience in price measurement in high-technology industries. They prepared a report that reviewed the basic issues, considered the options, analyzed examples of Medicare price indices, and recommended a specific index form that they concluded was most appropriate (Joel Popkin and Company, 1990). This recommendation is used in the indices presented in this report.

The remainder of this report is organized as follows: In the next section, we summarize the conceptual basis for selecting an appropriate index form. For expositional purposes, issues related to the time series indices are addressed separately from those specific to the cross-section indices. We then describe how the specific services to be included in the indices were selected and how their relative importance varies both across years and areas. The next two sections contain actual index values for the time-series and cross-sectional indices, respectively. We conclude by explaining how these indices will be used in our analysis of Medicare physician service volume.

## II. CONCEPTUAL FOUNDATION[2]

### Time Series Indices

The basic requirement of these indices is that when the change in Medicare expenditures per enrollee between two points in time is deflated by the corresponding price index, the result is a measure of the change in the volume

2. This section is based on material from Joel Popkin and Company (1990).

and intensity of services. Since there are a variety of index forms that can satisfy this criterion, the ultimate choice will depend on the underlying economic assumptions regarding the services produced. As indicated above, the price index will have to accommodate the rapid technological changes that take place in the physician services market. While this may eliminate a priori the most common index forms (e.g., Laspeyres and Paasche), it need not lead to unmanageable complexities in the index structure.

We start by reviewing the Laspeyres and Paasche index forms because it is possible to combine these indices into other index forms that may be more appropriate in this application. The Laspeyres index compares prices in a current year to those in some previous base year, using base year quantities as the weights. Algebraically, this can be represented as:

$$LASP = \frac{\sum_i P_c^i Q_b^i}{\sum_i P_b^i Q_b^i} = \sum_i \frac{P_b^i Q_b^i}{\sum_i P_b^i Q_b^i} * \frac{P_c^i}{P_b^i} \qquad (1)$$

where P and Q denote price and quantity, respectively; i is a superscript identifying individual services; and c and b subscripts for the current and base year time periods. The final expression in equation 1 shows a formulation of the index as the sum of the products of relative prices and expenditure shares. This is useful because expenditure share data are often more readily available than quantity data.

A typical criticism of this index is that, to the extent individuals substitute less costly for more costly goods over time, it can overstate actual price changes by relying on base year weights. In the context of measuring Medicare price changes the direction of "substitution bias" may not be the

same. In Medicare, new services that are introduced are often more costly than those that are eliminated. This would cause a Laspeyres price index to understate the extent of price change and lead to an overestimate in the growth in volume and intensity.

The Paasche index suffers from problems that are a mirror image of those of the Laspeyres. The Paasche index makes price comparisons that use current period quantities as the weights. Its algebraic formula is:

$$PAS = \frac{\sum_i P_c^i Q_c^i}{\sum_i P_b^i Q_c^i} = \frac{1}{\sum_i \frac{P_c^i Q_c^i}{\sum_i P_c^i Q_c^i} * \frac{P_b^i}{P_c^i}} \qquad (2)$$

Again, the final term is a representation of the index that allows for the use of expenditure shares as weights. Under usual consumption behavior, this suggests that the Paasche is a lower bound on price change. However, in the case of Medicare, by putting more weight on the newer procedures the Paasche might be considered an upper bound on prices.

Intuitively, averaging between two indices that may be conveying extreme information about price changes should produce an index that is a better measure of actual price change. The Fisher's Ideal index, the geometric mean of a Laspeyres and Paasche index, takes just this approach. Computationally, the Fisher's Ideal is the square root of the product of the two indices shown in equations 1 and 2 above. By solely relying on neither base-year or current-year quantity weights, Fisher's Ideal index embodies a broader range of economic behaviors (i.e., it does not require that the mix of services used is invariant with respect to price as do the Laspeyres and Paasche indices) and

is, therefore, less susceptible to substitution biases. Moreover, it must lie between the Laspeyres and Paasche bounds. Another index that averages across base- and current-year weights is the Tornquist index. While this index is even more general than Fisher's, its computation involves logs of price ratios and cannot be related to the more common index forms as easily.

Because the ultimate use of this price index will be to deflate expenditure growth and develop an index of volume and intensity growth, it is useful to consider the characteristics of the resulting volume and intensity index associated with each price index. It is shown in the Joel Popkin and Company report (1990) that when expenditure growth is deflated by a Laspeyres price index, the volume and intensity index will have a Paasche form. [The full Popkin and Co. report is included as Appendix A.] This means that volume and intensity changes will be weighted by current year price weights. If the price index has the form of a Fisher's Ideal index, however, the volume and intensity index is also Fisher's Ideal. Therefore, one benefit of adopting the Fisher's index for prices is that it does not require the introduction of an alternative index structure for volume and intensity. Moreover, the product of the Fisher's price index and the Fisher's volume and intensity index equals a measure of expenditure growth.

While this discussion suggests that the Fisher's Ideal index may be the most promising form of the price index, it does not necessarily deal with the issue of rapidly changing service mix over time. This manifests itself in two ways. First, the weights that would be used in the Laspeyres part of the Fisher's index would become outdated over time and unrepresentative of what is actually purchased. This occurs because the Fisher's Ideal still requires that the same prices be included in both the Laspeyres and Paasche components of the

index. Second, as new services replace old ones, it may become increasingly difficult to observe prices for all of the services included in the index.

These problems would suggest that it would be desirable to be able to update both the services included in the index and the weights frequently. The BMAD data that will be used to compute these indices allows for the possibility of selecting new procedures and reweighting annually. This would allow us to compute price change on an annual basis using different procedures and different weights for each pair of years. To create indices for price changes over periods longer than a year we would "chain" the annual indices together. Chained indices are simply the products of individual annual indices. This means that price change between 1985 and 1989 would be measured as the product of annual changes between 1985 and 1986, 1986 and 1987, 1987 and 1988, and 1988 and 1989.

Therefore, it is chaining that solves the problem of how to capture the prices of new procedures and changing weights in the price index and still measure price change over a period of several years. For example, consider the case of MRIs. This relatively new procedure was not widely introduced to Medicare patients until 1986. With chaining, it would have a significant impact on price changes between 1986 and 1987, but would not be important in computing price changes in a prior period. If we did not chain the index and used 1985 (the first year of this study) as the base year, we would be excluding price changes for MRI services from our index of advanced imaging services, even though they are replacing or supplementing some of the services that were being providing in 1985.

The ability of the Fisher's Ideal index to capture responsiveness to relative price changes combined with the feature that chaining readily allows for the introduction of new procedures and shifting weights suggests that an

acceptable index of price change can be computed using the chained Fisher's Ideal form. It is that form that will be used in this study.

Cross-Section Indices

These indices will be used to deflate Medicare expenditures at a given point in time so that geographic differentials in volume and intensity can be examined. For each area, we would need to develop a price measure that compares each areas prices to national average prices. This index could then be used to deflate the ratio of area expenditures to national average expenditures to focus solely on volume and intensity variations.

While the most straightforward approach would base the index on the price of a nationally-representative basket of Medicare services in each area of the country (a Laspeyres form), it has several problems. First, not all services that would be considered important in aggregate spending data are provided in each area of the country. Therefore, it would be impossible to price the representative market basket in each area. Second, since the relative importance of each service may vary from area to area, it would be hard to defend the idea that differences in expenditures deflated by the price index would represent volume and intensity differences and not service mix. Service mix may vary because of geographic variation in relative prices, which is extensive (Escarce, 1990). This is the "substitution bias" issue in a cross-section context. However, preliminary analysis of the data suggest that service mix varies much more cross-sectionally than it does over time, making this an even more central issue to address here.

This substitution bias issue would suggest that, for most goods and services, a cross-sectional Laspeyres index would overstate true price differences. However, if measuring price differences were the only reason for

creating this index, there might be some benefits to the conceptual simplicity of being able to say that we were comparing prices for the same set of products. Since we plan to be using this index as a expenditure deflator, we must be concerned about how distortions in price measurement will affect volume and intensity. If prices differentials were overstated, then volume and intensity variation would be understated.

This pattern would be consistent with standard economic theory which suggests that an area will reduce the consumption of its relatively high-priced services and expand the low-priced services. This would lead to less cross-sectional variation in the weights for high-priced than for low priced services, if computed separately for each area. However, in the case of physician services, it appears that area-level weights for high-priced services vary more than those low-cost services. Possibly, this is due to the fact that new technologies tend to have higher prices and are introduced at differential rates across areas. This means that a Laspeyres index that relied on national weights would tend to understate price differentials and overstate variation in volume and intensity.

Using a Paasche index in which the weights were different for each area would of course get around the problem that some services that are important overall are not produced in every area. This would provide information on the prices of the area's market basket of services if it were purchased at the national average allowed charges. However, there would be no link to the national average importance of each service as there is in a Laspeyres index. Given the greater extent of geographic variation in the relative importance of high-priced services, the Paasche would lead to understatement of price variation and overstatement of volume and intensity differences, the reverse of the Laspeyres problem.

This reasoning leads, once again, to adopting the Fisher's Ideal index. However, since changes over time are not an issue in a cross-sectional index no chaining is involved. The index is formed as the product of a Laspeyres index that uses national weights for the services produced in a given area and a Paasche index that uses area-specific weights. An important point to keep in mind in thinking about this index is that the services included in the computation for a particular area may differ from those included in another area. The resulting price index will measure the difference in prices between the area and the nation for those services purchased in the area, thus a direct comparison between areas is not appropriate. The cross-sectional Fisher's Ideal will be computed for each type of service and for all services.

One characteristic of price indices - circularity - needs to be discussed. An index that has this property would be able to take comparisons between pairs of areas and obtain meaningful results regarding areas not in the same pair. If the Fisher's Ideal were circular, for example, knowing that prices in area A were 5 percent above the national average and prices in area B were 10 percent above the national average would allow one to conclude that prices were 5 percent higher in area B than in area A. This, however, would not generally be true. The reason for this is that a Fisher's Ideal that compared area A to area B would be likely to be based on different services than either of the comparisons between A or B and the national average. This shortcoming of the Fisher's index is also a problem for the Laspeyres or Paasche indices. Therefore, the cross-sectional indices will not allow for comparisons between geographic areas; comparisons will only be valid between each area for which an index is computed and the national average.[3]

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3. The circularity issue is also related to time-series indices as well. The product of the three annual Fisher's Ideal indices between, say, 1985 and

## III. EMPIRICAL APPROACH

The data used to compute these price indices will be drawn from the 1985 through 1989 BMAD Procedure Files. The cross-sectional indices will only be computed for 1988. The price of each service will be measured as the Medicare average allowed charge. In both the time-series and cross-section contexts, indices will be computed for each of the Berenson and Holahan type of service categories at the area level. This allows for geographic variations in price changes by type of service to be captured by the indices and reflected in computations of volume and intensity growth.

The areas that are used are either Medicare pricing localities or aggregations of localities. Localities were aggregated in order to create areas that are more commonly analyzed. Specifically, we tried to aggregate localities in order to forms MSAs and rural areas of states. In the case of statewide localities, this was not possible and an area represents an entire state. In other instances, it was not possible to separate small MSAs from the rural areas of states. The full set of 121 geographic areas used in this study are shown in Appendix B. Labelling to the contrary, the areas identified by MSA names may not conform to the Census definitions of these areas; deviations are due to the constraint of building these areas from the localities. These areas are the same as those used in a previous paper in this study (Holahan and Zuckerman, 1991).

Given the index structure and the area definitions, the major remaining issue relates to specific services whose prices will be included in the index.

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1988 will not yield the same measure of price change as a Fisher's Ideal computed on the three-year change in price during the 1985 to 1988 period (a single number). However, since the time-series indices used here will all be chained, the lack of circularity is not a relevant problem.

Services are defined as individual HCPCS codes in all instances except imaging. For imaging, services that represent a global payment are treated distinctly for those that are for the professional component only. Including many services improves the credibility of the indices as expenditure deflators. However, to the extent that price changes and geographic differentials are correlated across procedures, it is not necessary to include as many procedures to derive representative indices of prices. Moreover, as the numbers of procedures are increased, computation of the index would become cumbersome.

Therefore, we include in the indices only those procedures that account for some minimum percentage of Medicare allowed charges within each type of service category. Specifically, if a service accounts for at least 1.5 percent of the Medicare revenue in a type of service category within an area it is included in the cross-section index. For the time-series index, a service is included if it accounts for 1.5 percent of the Medicare revenue in a service category in either of the two years across which the annual Fisher's Ideal index is computed. This results in the exclusion of many services from the indices. However, the excluded services each account for a very small share of spending and, as a result, would have low weights and very little impact on the index values. Once selected, the weight assigned to each price is the share of total allowed charges accounted for by that service within the services selected from each type of service category.

To provide a sense of the results of this service selection process, the services included in the market baskets used to compute price change at the national level, along with their weights in 1985 and 1988, are displayed in Table 1 for three types of services. These market baskets vary from area to area. As can be seen, the weights do not remains stable across years, even when the specific services included in the index are fairly constant. Office

Table 1

National-Level Expenditure Shares Used in Time-Series Price Index for Selected Types of Services
1985 and 1988

| CPT Code and Procedure Description | Expenditure Shares* 1985 | 1988 |
|---|---|---|
| ADVANCED IMAGING | | |
| 70450 Computerized Axial Tomography, Head or Brain without Contrast Material, PC | 0.161 | 0.147 |
| 70450 Computerized Axial Tomography, Head or Brain without Contrast Material | 1.035 | 0.026 |
| 70460 Computerized Axial Tomography, Head or Brain with Contrast Material(s), PC | 0.085 | 0.034 |
| 70460 Computerized Axial Tomography, Head or Brain with Contrast Material(s) | 0.025 | -- |
| 70470 Computerized Axial Tomography, Head or Brain without Contrast Material, Followed by Contrast Material(s) and Further Sections, PC | 0.201 | 0.123 |
| 70470 Computerized Axial Tomography, Head or Brain without Contrast Material, Followed by Contrast Material(s) and Further Sections | 0.061 | 0.042 |
| 70551 Magnetic Resonance (e.g., Proton) Imaging, Brain (including Brain Stem, PC | --- | 0.030 |
| 70551 Magnetic Resonance (e.g., Proton) Imaging, Brain (including Brain Stem | 0.001 | 0.090 |
| 71250 Computerized Axial Tomography, Thorax without Contrast Material, PC | 0.029 | 0.025 |
| 71260 Computerized Axial Tomography, Thorax with Contrast Material(s), PC | 0.042 | 0.038 |
| 72131 Computerized Axial Tomography, Lumbar Spine without Contrast Material, PC | 0.035 | 0.032 |
| 72131 Computerized Axial Tomography, Lumbar Spine without Contrast Material | 0.021 | 0.027 |
| 72141 Magnetic Resonance (e.g., Proton) Imaging, Spinal Canal & Contents, Cervical | --- | 0.026 |
| 72144 Magnetic Resonance (e.g., Proton) Imaging, Spinal Canal & Contents, Lumbar | --- | 0.041 |
| 72193 Computerized Axial Tomography, Pelvis with Contrast Material(s), PC | 0.025 | 0.034 |
| 72193 Computerized Axial Tomography, Pelvis with Contrast Material(s) | -- | 0.015 |
| 74150 Computerized Axial Tomography, Abdomen without Contrast Material, PC | 0.052 | 0.039 |
| 74160 Computerized Axial Tomography, Abdomen with Contrast Material(s), PC | 0.110 | 0.095 |
| 74160 Computerized Axial Tomography, Abdomen with Contrast Material(s) | 0.029 | 0.038 |
| 74170 Computerized Axial Tomography, Abdomen without Contrast Material, Followed by Contrast Material(s) and Further Sections, PC | 0.067 | 0.055 |
| 74170 Computerized Axial Tomography, Abdomen without Contrast Material, Followed by Contrast Material(s) and Further Sections | 0.022 | 0.027 |
| OFFICE VISITS | | |
| 90010 Office Medical Service, New Patient Limited Service | 0.020 | --- |
| 90015 Office Medical Service, New Patient Intermediate Service | 0.030 | 0.029 |
| 90020 Office Medical Service, New Patient Comprehensive Service | 0.057 | 0.060 |
| 90040 Office Medical Service, Established Patient Brief Service | 0.108 | 0.068 |
| 90050 Office Medical Service, Established Patient Limited Service | 0.317 | 0.296 |
| 90060 Office Medical Service, Established Patient Intermediate Service | 0.319 | 0.375 |
| 90070 Office Medical Service, Established Patient Extended Service | 0.081 | 0.103 |
| 90080 Office Medical Service, Established Patient Comprehensive Service | 0.068 | 0.069 |
| MAJOR PROCEDURES/CARDIOVASCULAR | | |
| 33206 Insertion of Permanent Pacemaker w/Transvenous Electrode(s), Atrial | 0.036 | --- |
| 33207 Insertion of Permanent Pacemaker w/Transvenous Electrode(s), Ventricular | 0.052 | 0.054 |
| 33208 Insertion of Permanent Pacemaker w/Transvenous Electrode(s), AV Sequential | 0.026 | 0.026 |
| 33210 Insertion of Temporary Transvenous Cardiac Electrode, or Pacemaker, Catheter (Separate Procedure) | 0.035 | 0.027 |
| 33405 Replacement, Aortic Valve, with Cardiopulmonary Bypass | 0.036 | 0.038 |
| 33511 Coronary Artery Bypass, Autogenous Graft (e.g., Saphenous Vein or Internal Mammary Artery) Two Coronary Grafts | 0.071 | 0.075 |
| 33512 Coronary Artery Bypass, Autogenous Graft (e.g., Saphenous Vein or Internal Mammary Artery) Three Coronary Grafts | 0.156 | 0.176 |
| 33513 Coronary Artery Bypass, Autogenous Graft (e.g., Saphenous Vein or Internal Mammary Artery) Four Coronary Grafts | 0.136 | 0.155 |
| 33514 Coronary Artery Bypass, Autogenous Graft (e.g., Saphenous Vein or Internal Mammary Artery) Five Coronary Grafts | 0.058 | 0.061 |
| 35081 Direct Repair of Aneurysm or Excision (Partial or Total) and Graft Insertion, with or without Patch Graft for Aneurysm or Occlusive Disease, Abdominal Aorta | 0.055 | 0.042 |
| 35301 Thromboendarterectomy, with or without Patch Graft Carotid, Vertebral, Subclavian, by Neck Incision | 0.156 | 0.091 |
| 35556 Bypass Graft, with Vein Femoral-Popliteal | 0.042 | --- |
| 35566 Bypass Graft, with Vein Femoral-Anterior Tibial, Posterior Tibial, or Peroneal Artery | 0.031 | 0.028 |
| 36489 Placement of Central Venous Catheter (Subclavian, Jugular, or Other Vein) (e.g., for Central Venous Pressure, Hyperalimentation, Hemodialysis, or Chemotherapy, Percutaneous, over Age 2 | --- | 0.028 |
| 36830 Creation of Arteriovenous Fistula Nonautogenous Graft | 0.031 | 0.036 |
| 92982 Percutaneous Transluminal Coronary Angioplasty Single Vessel | 0.030 | 0.114 |
| 93503 Right Heart Catheterization, Placement of Flow Directed Catheter (e.g., Swan-Ganz), with or without Tip, when Placed for Monitoring Purposes, Collection of Blood, and/or Angiography | 0.050 | 0.049 |

* These are from the Laspeyres Component of the Fisher's Ideal Index.

visits provide a good example of this phenomenon. Upcoding of office visits is suggested by these weights. The relative importance of limited office visits with established patients fell from a .108 share to .068. At the same time, extended visits were increasing from .318 to .375.

For the other types of services shown the importance of allowing the service mix to change over time is highlighted. In 1985, MRIs of the brain (CPT 70551) were barely relevant as a source of spending for advanced imaging, while CAT scans of the brain (CPT 70470) accounted for over one-quarter of all spending for index procedures. However, by 1988, the importance of these two procedures was much closer to equal, with both near 15 percent of the index. A similar pattern can be seen among major cardiovascular procedures. In this instance, we find atrial pacemaker insertions (CPT 33206) and thromboendarterectomy (CPT 35301) disappearing or diminishing in importance, while angioplasty (CPT 92982) is clearly growing.

The proportion of total allowed charges accounted for by the index services also varies by type of service. However, the index services represent less than two-thirds of 1989 allowed charges in only 5 of the 21 types of services. Among hospital visits, the included services account for 96.3% of charges in 1988. With the exception of specialist evaluation and management services, all of the visit and consultation categories include over 90 percent of charges. As the number of potential index services increases and their diversity grows, the share of charges accounted for by the index services tends to fall. In the extreme, the index services only account for 29.3% of allowed charges for other ambulatory procedures.

We have selected two areas - Rural Alabama and Los Angeles, CA - to contrast the services and weights included in the cross-section indices. Services and weights for both areas are shown in Table 2. These data show that

Table 2

Area-Level Expenditure Shares Used in the 1988 Cross-Sectional Price Index,
Rural Alabama and Los Angeles, California

| CPT Code and Procedure Description | Expenditure Shares* Rural Alabama | Los Angeles, CA |
|---|---|---|
| ADVANCED IMAGING | | |
| 70450 Computerized Axial Tomography, Head or Brain without Contrast Material, PC | 0.189 | 0.164 |
| 70450 Computerized Axial Tomography, Head or Brain without Contrast Material | --- | 0.033 |
| 70460 Computerized Axial Tomography, Head or Brain with Contrast Material(s), PC | 0.043 | --- |
| 70470 Computerized Axial Tomography, Head or Brain without Contrast Material, Followed by Contrast Material(s) and Further Sections, PC | 0.333 | 0.081 |
| 70470 Computerized Axial Tomography, Head or Brain without Contrast Material, Followed by Contrast Material(s) and Further Sections | --- | 0.044 |
| 70551 Magnetic Resonance (e.g., Proton) Imaging, Brain (including Brain Stem, PC | --- | 0.059 |
| 70551 Magnetic Resonance (e.g., Proton) Imaging, Brain (including Brain Stem | --- | 0.145 |
| 71250 Computerized Axial Tomography, Thorax without Contrast Material, PC | --- | 0.031 |
| 71260 Computerized Axial Tomography, Thorax with Contrast Material(s), PC | 0.053 | 0.023 |
| 71270 Computerized Axial Tomography, Thorax without Contrast Material Followed by Contrast Material(s) and Further Sections, PC | 0.020 | --- |
| 72131 Computerized Axial Tomography, Lumbar Spine without Contrast Material, PC | 0.046 | 0.023 |
| 72131 Computerized Axial Tomography, Lumbar Spine without Contrast Material | --- | 0.046 |
| 72141 Magnetic Resonance (e.g., Proton) Imaging, Spinal Canal & Contents, Cervical | --- | 0.043 |
| 72144 Magnetic Resonance (e.g., Proton) Imaging, Spinal Canal & Contents, Lumbar | --- | 0.061 |
| 72193 Computerized Axial Tomography, Pelvis with Contrast Material(s), PC | 0.057 | --- |
| 73720 Magnetic Resonance (e.g., Proton) Imaging, Lower Extremity, other than Joint | --- | 0.028 |
| 74150 Computerized Axial Tomography, Abdomen without Contrast Material, PC | 0.020 | 0.035 |
| 74160 Computerized Axial Tomography, Abdomen with Contrast Material(s), PC | 0.177 | 0.056 |
| 74160 Computerized Axial Tomography, Abdomen with Contrast Material(s) | --- | 0.042 |
| 74170 Computerized Axial Tomography, Abdomen without Contrast Material, Followed by Contrast Material(s) and Further Sections, PC | 0.061 | 0.047 |
| 74170 Computerized Axial Tomography, Abdomen without Contrast Material, Followed by Contrast Material(s) and Further Sections | --- | 0.037 |
| OFFICE VISITS | | |
| 90015 Office Medical Service, New Patient Intermediate Service | 0.020 | 0.023 |
| 90020 Office Medical Service, New Patient Comprehensive Service | 0.024 | 0.071 |
| 90040 Office Medical Service, Established Patient Brief Service | 0.140 | --- |
| 90050 Office Medical Service, Established Patient Limited Service | 0.111 | 0.168 |
| 90060 Office Medical Service, Established Patient Intermediate Service | 0.629 | 0.424 |
| 90070 Office Medical Service, Established Patient Extended Service | 0.051 | 0.241 |
| 90080 Office Medical Service, Established Patient Comprehensive Service | 0.026 | 0.073 |
| MAJOR PROCEDURES/CARDIOVASCULAR | | |
| 33206 Insertion of Permanent Pacemaker w/Transvenous Electrode(s), Atrial | 0.049 | --- |
| 33207 Insertion of Permanent Pacemaker w/Transvenous Electrode(s), Ventricular | 0.111 | 0.043 |
| 33208 Insertion of Permanent Pacemaker w/Transvenous Electrode(s), AV Sequential | 0.032 | 0.038 |
| 33210 Insertion of Temporary Transvenous Cardiac Electrode, or Pacemaker, Catheter (Separate Procedure) | 0.082 | --- |
| 33405 Replacement, Aortic Valve, with Cardiopulmonary Bypass | --- | 0.038 |
| 33511 Coronary Artery Bypass, Autogenous Graft (e.g., Saphenous Vein or Internal Mammary Artery) Two Coronary Grafts | --- | 0.062 |
| 33512 Coronary Artery Bypass, Autogenous Graft (e.g., Saphenous Vein or Internal Mammary Artery) Three Coronary Grafts | --- | 0.155 |
| 33513 Coronary Artery Bypass, Autogenous Graft (e.g., Saphenous Vein or Internal Mammary Artery) Four Coronary Grafts | --- | 0.149 |
| 33514 Coronary Artery Bypass, Autogenous Graft (e.g., Saphenous Vein or Internal Mammary Artery) Five Coronary Grafts | --- | 0.068 |
| 34201 Embolectomy or Thrombectomy, with or without Catheter Femoropopliteal, Aortoiliac Artery, by Leg Incision | 0.038 | --- |
| 35081 Direct Repair of Aneurysm or Excision (Partial or Total) and Graft Insertion, with or without Patch Graft for Aneurysm or Occlusive Disease, Abdominal Aorta | 0.051 | 0.047 |
| 35301 Thromboendarterectomy, with or without Patch Graft Carotid, Vertebral, Subclavian, by Neck Incision | 0.122 | 0.109 |
| 35556 Bypass Graft, with Vein Femoral-Popliteal | 0.036 | --- |
| 35566 Bypass Graft, with Vein Femoral-Anterior Tibial, Posterior Tibial, or Peroneal Artery | 0.049 | --- |
| 35656 Bypass Graft, with other than Vein Femoral-Popliteal | 0.066 | 0.034 |
| 35661 Bypass Graft, with other than Vein Femoral-Femoral | 0.023 | --- |
| 35875 Thrombectomy and/or Repair of Arterial or Venous Graft | 0.032 | --- |
| 36489 Placement of Central Venous Catheter (Subelavian, Jugular, or Other Vein) (e.g., for Central Venous Pressure, Hyperalimentation, Hemodialysis, or Chemotherapy, Pereutaneous, over Age 2 | 0.069 | 0.041 |
| 36830 Creation of Arteriovenous Fistula Nonautogenous Graft | 0.030 | 0.081 |
| 92950 Cardiopulmonary Resuscitation (e.g., in Cardiac Arrest) | 0.038 | --- |
| 92982 Pereutaneous Transluminal Coronary Angioplasty Single Vessel | --- | 0.092 |
| 93503 Right Heart Cateheterization, Placement of Flow Directed Catheter (e.g., Swan-Ganz), with or without Tip, when Placed for Monitoring Purposes, Collection of Blood, and/or Angiography | 0.171 | 0.042 |

* These are the expenditure shares from the Paasche Component of the Fisher's Ideal Index.

the services used in a particular type of service category can differ dramatically across areas. For example, none of the MRI procedures are of sufficient importance in Rural Alabama to be included in the index. In contrast, the mix of advanced imaging procedures in Los Angeles is much closer to the national market basket shown in Table 1. Analogously, we find no coronary artery bypass or angioplasty procedures passing the index screens in Rural Alabama, but virtually all are included in the Los Angeles index.

Even when the services included in the index are essentially the same, as in the case of office visits, the weight differences highlight the need for using an index that takes area-level variations into account. An intermediate office visit with an established patient is the most important visit code in both areas (as it is nationally). However, its weight is about 50 percent higher in Rural Alabama than in Los Angeles. This is offset by a substantially lower weight for extended visits with established patients. Being able to allow the weights to differ is precisely the attractiveness of the Fisher's Ideal Index in that it provides a more credible comparison between each area's prices and the national average.

While the individual type of service price indices present a detailed picture of price change and variation across areas, there may be interest in more aggregate price measures. How did prices for all Medicare physician services change over a given time period? How did prices for services provided by, say, orthopedists change? What is the average differential in prices across all services for an area relative to the national average? Intuitively, one might be led to answer these questions by computing a weighted average Fisher's Ideal index where the weights were the share of total allowed charges represented by each type of service category across, for example, all specialties, a given specialty, or within an area. However, this is not

correct. Because the Fisher's Ideal is not a linear combination of prices, its values cannot be combined linearly either.

To compute aggregate measures of price in the Fisher's context, weighted average Laspeyres and Paasche indices must be computed. Since these indices are linear combinations of prices, their values can be aggregated using the relevant shares of allowed charges for each type of service as the weights. The formulas for these aggregations across each of the j type of service categories are as follows:

$$LASP = \sum_j W_j \, LASP_j; \text{ and}$$
$$PAS = \sum_j K_j \, PAS_j \qquad (3)$$

where w and k represent shares of allowed charges for each type of service in the base and current periods, respectively. The geometric mean of these average Laspeyres and Paasche indices would be the appropriate Fisher's Ideal index for the aggregated types of services. This approach allows us to develop price indices for all services as well as specialty-specific price indices in which the type of service weights differ by specialty.

## IV. RESULTS

Table 3 shows the national time-series indices for all services and for each type of service category by year. Overall, this approach indicates that average Medicare allowed charges rose by 14.7 percent between 1985 and 1989, or 3.5 percent annually. However, this rate of growth was not uniform across years or types of services. Prices grew most rapidly, 9.4 percent annually,

Table 3

National Average Price Changes in Medicare Physician Services, 1985–1989, by Type of Service

| Type of Service | Fisher's Ideal Index 1985–86 | 1986–87 | 1987–88 | 1988–89 | Chained Fisher's Ideal Index 1985–89 |
|---|---|---|---|---|---|
| ALL SERVICES | 1.042 | 1.072 | 1.003 | 1.024 | 1.147 |
| Standard Imaging | 1.049 | 1.063 | 1.018 | 1.019 | 1.157 |
| Advanced Imaging | 1.111 | 1.137 | 1.018 | 0.884 | 1.137 |
| Sonography | 1.071 | 1.028 | 0.969 | 1.044 | 1.113 |
| Imaging/Procedures | 1.065 | 1.084 | 1.028 | 1.020 | 1.210 |
| Office Visits | 1.041 | 1.081 | 1.030 | 1.055 | 1.222 |
| Hospital Visits | 1.051 | 1.078 | 1.021 | 1.041 | 1.204 |
| Emergency Room Services | 0.999 | 1.068 | 1.075 | 1.071 | 1.228 |
| Non-Hospital, Non-Specialist Visits | 1.042 | 1.096 | 1.018 | 1.048 | 1.217 |
| Specialist Evaluation & Management Serv | 1.063 | 1.090 | 1.024 | 1.032 | 1.225 |
| Consultations | 1.026 | 1.079 | 1.023 | 1.030 | 1.167 |
| Major Procedures - Other | 1.026 | 1.047 | 1.009 | 1.015 | 1.100 |
| Major Cardiovascular Procedures | 1.050 | 1.098 | 1.014 | 1.007 | 1.176 |
| Major Orthopedic Procedures | 1.040 | 1.059 | 0.991 | 1.017 | 1.110 |
| Ambulatory Procedures - Other | 1.019 | 1.075 | 1.017 | 1.021 | 1.137 |
| Ambulatory Procedures - Eye | 1.005 | 1.027 | 0.968 | 1.012 | 1.010 |
| Minor Procedures | 1.034 | 1.062 | 1.015 | 1.037 | 1.155 |
| Oncology Services | 1.120 | 1.104 | 1.068 | 1.085 | 1.433 |
| Endoscopy Procedures | 1.048 | 1.088 | 0.980 | 1.023 | 1.144 |
| Laboratory Tests | 1.046 | 1.135 | 0.881 | 0.985 | 1.030 |
| Other Tests | 1.039 | 1.116 | 1.032 | 1.038 | 1.242 |

for oncology services. At the other extreme, prices for ambulatory eye procedures grew by less than 1 percent. Over time, average allowed charges increased at rates of 4.2 percent in 1985-1986, 7.2 percent in 1986-1987, 0.3 percent in 1987-1988, and 2.4 percent in the last period.

In part, price growth varied over time because of differences in the size of Medicare Economic Index (MEI) fee updates, when they were implemented within a given year, and the numbers of services that were updated. In 1986, only participating (PAR) physicians received an MEI increase in their prevailing charges. This increase was 4.2 percent, but was not applied until April 1st. This means that, during the first quarter of 1986, even PAR fees remained at 1985 levels. In contrast, the MEI update in prevailing charges for 1987 - 3.2 percent - was applied to all procedures and physicians as of January 1st. Even though the MEI update percentage was somewhat smaller in 1987 than in 1986, the fact that it applied to more physicians and was in place for all of 1987 would suggest that the average allowed fee could have increased by more between 1986 and 1987 than between 1985 and 1986. This is precisely what is reflected in the price indices we computed.[4]

In both 1988 and 1989, MEI updates were far less generous. As in 1986, the MEI update for 1988 was not implemented until April 1st. At that time, there was a 3.2 percent increase in prevailing charges for primary care

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4. One reason that prices diverge from the MEI is that the MEI controls the rate of increase in prevailing charges and many services are still paid on the basis of customary charges that are not limited to MEI updates. To the extent that the proportion of services paid at the customary charge varies by type of service, the rate of increase in prices will vary by type of service. Although we have no data on the proportion of services paid at the customary by type of service, it appears that rapid price growth occurs more frequently among nigh technology and newer services. For example, between 1985 and 1987 the large increase in allowed charges occurred in advanced imaging, imaging with a procedure, major cardiovascular procedures and oncology services. All of these categories involve emerging procedures that are more likely to have not yet reached the prevailing charge ceiling.

services, but only a 1 percent increase for all other services. In January of 1989, PAR physicians received another similar increase in prevailing charges, while non-participants were given increases one-half percentage point lower. Not surprisingly, price increases in both the 1987-1988 and 1988-1989 periods were lower than those observed in the earlier years. It also appears that the delayed MEI update contributed to 1988 being the year exhibiting the lowest rate of average allowed charge inflation.

However, the observed rates of price change as well as the variations across types of services were not simply the result of the the MEI updates. There were several explicit policies implemented during this period that were intended to lower payments for specific services. The price indices are able to detect the impact of all of these policy changes. First, was the April 1, 1988 reductions in prevailing charges for twelve procedures characterized as "overvalued." These twelve procedures were hip replacement, knee arthroplasty, knee arthroscopy, bronchoscopy, pacemaker insertion, coronary artery bypass graft, upper GI endoscopy, transurethral resection of the prostate, suprapubic prostatectomy, dilation & curretage, carpal tunnel repair, and cataract extractions and involved 37 HCPCS codes. In terms of the Berenson and Holahan type of service categories, this policy predominantly affected fee increases for endoscopies, all three types of major procedures, and ambulatory eye procedures. In three of these five instances, fees actually fell between between 1987 and 1988. For example, endoscopy fees that had grown by 4.8 percent in 1985-86 and 8.8 percent in 1986-87 fell by 2.0 percent in the year the regulations went into affect.

The second observed policy effect was related to a 1988 reduction in the cap on clinical laboratory payment amounts to the median areawide fee schedule from 115 percent of the median. This caused laboratory tests fees to fall by

11.9 percent after growing by 4.6 and 13.5 percent in the preceding years. The third was the implementation of the radiology fee schedule that tended to lower fees for CAT scans and MRIs in 1989. This was associated with a 11.6 percent reduction in advanced imaging prices between 1988 and 1989. Fourth, there was a major cut in the amount Medicare paid for several sonography procedures performed by ophthalmologists in 1988. The relative importance of this procedure combined with the magnitude of its fees led to a 3.1 percent cut in average sonography fees between 1987 and 1988.

Many of the HCPCS codes affected by these policies appear in the price index computation. Since the price indices do not include all procedures in a type of service category, they assign a greater importance to the procedures affected by the policies than they have in terms of their share of Medicare payments. The result is that the index tends to overstate the impact of these policies on price changes and understate the true rate of increase in Medicare allowed charges for the types of services including these HCPCS codes. However, potential distortions are not likely to be large if the index services account for a large share of the allowed charges in a type of service or if the policies applied to services other than those appearing in the index (as in the case of the imaging and laboratory payment changes).

The types of services whose indices may have been most affected by the selective inclusion of services during this period were ambulatory eye procedures, major procedures (cardiovascular, orthopedic, and other), endoscopies, and sonography. However, in only one instance - other major procedures - is the share of allowed charges sufficiently low (35.0 percent in 1988) so as to be seriously concerned about distortions. In all likelihood, the 0.9 percent increase in prices for these services understates the true price growth for other major procedures between 1987 and 1988. This occurs

because of the fact that transurethral resection of the prostate (CPT 52601), an overvalued procedure, appears in the index with a large weight.

Based on the relative importance of each type of service to the various physician specialties, the indices in Table 3 can be aggregated into specialty-specific indices of price change. These indices are shown in Table 4 for the 12 individual specialties accounting for the largest shares of Medicare spending and for three residual specialty categories (other medical, other surgical, and other non-physician). Given the slow price growth in ambulatory eye procedures and laboratory tests, it is not surprising to find that ophthalmologists and pathologists/laboratories experienced the slowest growth in Medicare fees. In general, it appears that fees for surgical specialties tended to grow more slowly than fees for medical specialties. However, ophthalmology aside, the differentials are not large. On an annual basis over this period, fees for the fastest growing medical specialty (cardiovascular disease) were only growing about 3 percent more quickly than the slowest growing surgical specialty (urology).

Table 5 displays time-series price indices for all types of services by area type. As can be seen, most of the price changes were quite similar. In fact, the variation across area types was not statistically significant (based on an F-test).[5] However, prices grew most rapidly in the 11 rural areas that

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5. Area-level analyses show that prices did not increase uniformly through out the country. However, the differences were generally not excessive. In 108 of the 121 areas, the average annual increase in prices was between 1 and 7 percent during the five year period. Several areas did lay outside of these bounds. Prices grew most rapidly in Illinois. By 1989, Medicare average allowed charges in Chicago were almost 48 percent above their 1985 levels, a 10.2 percent annual growth rate. The data suggests that average allowed charges actually fell over this period in Colorado, Maryland, and Michigan. When examined on an annual basis, these overall price reductions are due to a large fall in prices in a single year and may indicate some data reporting problems in these areas.

Table 4

National Average Price Changes in Medicare Physician Services, 1985-1989, by Specialty

| Specialty | Fisher's Ideal Index 1985-86 | 1986-87 | 1987-88 | 1988-89 | Chained Fisher's Ideal Index 1985-89 |
|---|---|---|---|---|---|
| ALL SPECIALTIES | 1.042 | 1.072 | 1.003 | 1.024 | 1.147 |
| Medical | | | | | |
| General/Family Practice | 1.041 | 1.081 | 1.014 | 1.040 | 1.187 |
| Internal Medicine | 1.045 | 1.083 | 1.012 | 1.037 | 1.187 |
| Cardiovascular Disease | 1.048 | 1.084 | 1.016 | 1.031 | 1.191 |
| Gastroenterology | 1.045 | 1.085 | 0.994 | 1.028 | 1.158 |
| Psychiatry | 1.057 | 1.081 | 1.021 | 1.035 | 1.208 |
| Other Medical | 1.044 | 1.081 | 1.018 | 1.035 | 1.189 |
| Surgical | | | | | |
| General Surgery | 1.035 | 1.067 | 1.010 | 1.021 | 1.138 |
| Orthopedic Surgery | 1.039 | 1.062 | 1.001 | 1.023 | 1.130 |
| Ophthalmology | 1.020 | 1.037 | 0.980 | 1.018 | 1.055 |
| Thoracic Surgery | 1.046 | 1.088 | 1.012 | 1.011 | 1.165 |
| Urology | 1.034 | 1.064 | 1.000 | 1.023 | 1.126 |
| Dermatology | 1.033 | 1.069 | 1.017 | 1.034 | 1.161 |
| Other Surgical Specialty | 1.033 | 1.065 | 1.011 | 1.026 | 1.140 |
| Other | | | | | |
| Radiology | 1.073 | 1.085 | 1.022 | 0.994 | 1.182 |
| Pathology/Laboratory | 1.050 | 1.117 | 0.921 | 0.999 | 1.078 |
| Multi-Specialty Group Practice | 1.042 | 1.072 | 1.012 | 1.028 | 1.162 |
| Other Non-Physician | 1.037 | 1.027 | 0.991 | 1.028 | 1.085 |

Source: 1985-1989 BMAD Procedure File.

Table 5

Average Price Changes in Medicare Physician Services by Area Type

| Area Type | Fisher's Ideal Index 1985-86 | 1986-87 | 1987-88 | 1988-89 | Chained Fisher's Ideal Index 1985-89 |
|---|---|---|---|---|---|
| NATIONAL | 1.042 | 1.072 | 1.003 | 1.024 | 1.147 |
| Very Large Cities | 1.046 | 1.058 | 1.009 | 1.017 | 1.135 |
| Large Cities Adjacent | 1.037 | 1.074 | 0.993 | 1.008 | 1.115 |
| Large Cities Non-Adjacent | 1.028 | 1.083 | 1.002 | 1.026 | 1.144 |
| Small Cities | 1.048 | 1.079 | 1.004 | 1.030 | 1.169 |
| Small Cities/Rural | 1.029 | 1.041 | 1.022 | 1.023 | 1.121 |
| Rural | 1.036 | 1.106 | 1.000 | 1.035 | 1.185 |
| Statewide | 1.058 | 1.059 | 0.995 | 1.016 | 1.133 |

could be clearly identified through the locality structure. Prices were 18.5 percent higher in these areas in 1989 than in 1985; a 4.3 percent annual growth rate. The second fastest growth occurred in the 24 small city areas; 4 percent annually. Somewhat surprisingly, however, areas that were a combination of small cities and rural areas had price increases, on average, that were near the lowest observed; 2.9 percent annually. It appears that kind of anomaly is, in part, due to the large degree of random fluctuation within area types.

Turning to the cross-sectional indices, we continue to use Rural Alabama and Los Angeles as examples. Table 6 shows the cross-sectional Fisher's Ideal indices for each type of service in these two areas. In Los Angeles, 1988 prices were above the national average for all types of services. This is somewhat unique in that most areas had some types of service with fees above the national average and others with fees below. Across all services, Los Angeles fee are 33.7 percent above the average nationally. The smallest differential in Los Angeles was for laboratory services, whose fees were only 14.6 percent above the average. These fees may be less dispersed than those for other types of services because of the caps on laboratory payments. Other major procedures, on the other hand, were paid at rates that were over 50 percent above the average rates in the country.

Rural Alabama has fees that are typically below the national average. On average, this differential is 16.5 percent for all services. For the most important type of service in terms of Medicare payments, office visits, fees are over 25.5 percent below the national average. The greatest difference in fee occurs in ambulatory eye procedures, where fees in Rural Alabama are 26.6 percent below the national average. Despite this general pattern, fees for both orthopedic procedures and laboratory tests are paid at rates slightly above the national average.

Table 6

Geographic Differentials in Prices for Medicare Physician Services for Rural Alabama and Los Angeles, CA by Type of Service, 1988

| Type of Service | Rural Alabama | Los Angeles California |
|---|---|---|
| ALL SERVICES | 0.835 | 1.337 |
| Standard Imaging | 0.914 | 1.236 |
| Advanced Imaging | 0.791 | 1.470 |
| Sonography | 0.734 | 1.316 |
| Imaging/Procedures | 0.897 | 1.322 |
| Office Visits | 0.745 | 1.398 |
| Hospital Visits | 0.835 | 1.346 |
| Emergency Room Services | 0.900 | 1.417 |
| Non-Hospital, Non-Specialist Visits | 0.700 | 1.381 |
| Specialist Evaluation & Management Services | 0.882 | 1.336 |
| Consultations | 0.851 | 1.379 |
| Major Procedures - Other | 0.928 | 1.507 |
| Cardiovascular | 0.812 | 1.259 |
| Orthopedic | 1.064 | 1.357 |
| Ambulatory Procedures - Other | 0.855 | 1.423 |
| Ambulatory Procedures - Eye | 0.634 | 1.246 |
| Minor Procedures | 0.741 | 1.322 |
| Oncology Services | 0.686 | 1.440 |
| Endoscopy Procedures | 0.824 | 1.287 |
| Laboratory Tests | 1.012 | 1.146 |
| Other Tests | 0.895 | 1.317 |
| Exceptions/Unclassified | 0.847 | 1.344 |

Source: 1988 BMAD Procedure File

The individual type of service indices have been aggregated into an index of the overall geographic differentials in fees for each area of the country. Table 7 displays these indices grouped by area type. Appendix C shows the index value for each individual area. Unlike the time-series indices, the observed variation in the levels of fees across types of areas is statistically significant. On average, Medicare payment rates are highest in the 10 very large cities that could be identified. In these areas, Medicare's fees exceed the national average by almost 20 percent. Fees are almost as high in the large cities adjacent to the largest cities. After that, fees drop off precipitously. In non-adjacent large cities, average fees are only 2 percent above the national average. Medicare prices are below the national average in all other area types shown. Fees are 6 to 7 percent below average in the three areas types that are all or part rural. Though the area definitions are not entirely consistent, these geographic differentials in allowed charges are similar to those suggested by the prevailing charge indices reported in Pope, et al. (1989).

As shown in Appendix C, fee differentials for individual areas are larger than those shown in Table 7. For example, in Small cities and rural Nebraska, Medicare's rates were 22 percent below the national average in 1988. At the same time, rates were 34 percent above average in Los Angeles, CA. To the extent that comparisons are possible between these indices and the impact analyses prepared for the preliminary Medicare Fee Schedule regulations (HCFA, 1991), it appears that areas with high allowed charge price index values will see payments fall and vice-versa.

Table 7

Geographic Differentials in Prices for Medicare Physician Services by Area Type, 1988

| Area Type | Cross-Sectional Fisher's Ideal Index for All Services |
|---|---|
| NATIONAL | 1.000 |
| Very Large Cities | 1.192 |
| Large Cities Adjacent | 1.179 |
| Large Cities Non-Adjacent | 1.021 |
| Small Cities | 0.978 |
| Small Cities/Rural | 0.936 |
| Rural | 0.936 |
| Statewide | 0.933 |

Source: 1988 BMAD Procedure File

## V. IMPLICATIONS

This study, along with the analysis in Joel Popkin and Company (1990), shows that price indices that rely on a single market basket of physician services with a fixed set of weights will not necessarily accurately measure price changes or geographic variations in Medicare fees. The reason for this is that, over time and across areas, both the mix of services and their relative importance can vary substantially. To address the issue of variations in the relative importance of procedures we adopted the Fisher's Ideal Index structure. In the time series context, this index incorporates the relative importance on procedures in both the base period and the current period. For cross-sectional comparisons, both the relative importance of procedures within an area and nationally are reflected in the index. If price changes are only measured over short periods of time, the ability of this index form to capture alternative weights within a single number may not be critical. On the other hand, given the wide variation in the relative importance of services across areas, this characteristic of the Fisher's Ideal Index is central to deriving valid cross-sectional comparisons.

However, changes in the mix of services over time can lead to serious distortions in the time-series indices. Ignoring the introduction of new services will result in an index that is based on an increasingly irrelevant market basket and, as such, to one that does not capture actual price changes very well. This problem is solved by using a "chained" index. A chained time-series price index measures price changes over several years as the product of individual annual price changes. Each annual price change may be measured using a different set of procedures and index weights, if circumstances warrant. Therefore, chaining combined with the Fisher's Ideal Index structure

yields an index of price change that accommodates new procedures and changes in relative importance over time.

A limitation of the cross-sectional Fisher's Ideal Index that is worth noting is that it does not allow for direct comparisons between areas, i.e., the index is not circular. Instead, each area's prices are compared to national average prices. In fact, as shown, the services used in the index in one area may be quite different than the services used in another area. However, since the primary reason for computing cross-sectional price indices is to determine how prices vary relative to the national average, it is more important have an index that makes this comparison in a useful manner than to search for a more complicated index that was circular. Readers should keep in mind that it is not variation in the index procedures that creates this limitation. Even a Laspeyres index that used a single market basket in all areas, a considerably more common index form, would not be valid for measuring the size of price differentials between areas.

Substantively, the indices show that Medicare policies during the study period - largely focusing on controlling prices for particular services - had their intended effects. Types of services that included procedures covered by the 1988 overpriced procedure cuts, the radiology fee schedule, the caps on laboratory payments rates, or limits on certain ophthalmic sonography procedures had lower rates of price growth than otherwise observed. This suggests that these indices can measure policy impacts and may be very useful as a device for measuring future price changes that will occur as a result of the Medicare Fee Schedule. In fact, if the numbers of services included in the indices were expanded to include more, or even all, HCPCS codes, indices of this type could comprehensively summarize the impact of this major policy change on prices.

Despite the noticeable impact of policies on prices for certain types of services, the range of price changes across service groups was smaller than the range of allowed charge changes reported in Berenson and Holahan (1990). That study found allowed charges by service category growing between 7 and 32 percent annually between 1985 and 1988. Our results suggests that differences in price growth among service categories were no more than 10 percent per year. In fact, eliminating oncology services, the range of annual price changes was between zero and six percent. This suggests that most of the differences reported by Berenson and Holahan (1990) are not due to price changes. In all likelihood, variations in volume and intensity growth are playing a major role. This issue will be explored more formally in a subsequent paper being prepared under this cooperative agreement.

The distribution of price changes across specialties was tighter than that by type of service. While this is consistent with the finding that specialties differentials in allowed charge growth were smaller than those by type of service (Holahan and Berenson, 1991), it remains that total allowed charges for most specialties were growing in excess of prices. Again, this would suggest that differences in volume and intensity growth across specialties may be as important as they are across types of services as an explanation of allowed charge differentials.

From a geographic standpoint, the two types of indices reported in this paper tell dramatically different stories. The time-series indices show that price changes did not vary much by area type. The cross-sectional indices, on the other hand, show that the levels of 1988 prices varied widely by area type. These patterns suggest that prices were not converging to a great extent across areas during this period, although low-price areas did tend to have somewhat greater price growth than high-fee areas.

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# APPENDIX A

## Price Indexes for Use in Calculating Changes in Volumes of Physicians' Services Through Time and Across Geographical Areas

FINAL DRAFT REPORT ON:

# *Price Indexes for Use in Calculating Changes in Volumes of Physicians' Services Through Time and Across Geographical Areas*

Prepared for:

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Draft Report for
Urban Institute
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## Introduction

It has always been difficult to compile price indexes in markets where technology is changing rapidly. That is because new products and services come onto the market and older ones leave it with a high frequency. This creates several problems for price index compilers. One is that the volumes of goods and services that are used as weights in price indexes change rapidly, making the behavior of an index sensitive to the selection of the time period or location used as the base. A second problem is that prices of items reflecting older technologies get more difficult to obtain. A third concern is that new items are promptly identified and that their prices are introduced into price indexes in a timely way.

The market for medical services is clearly characterized as one manifesting rapid technological change. As a result, medical care is perhaps the largest sector of gross national product -- just over 10 percent in 1989 -- for which controversy abounds about price measurement. Thus, the development of price indexes for medical care services requires that issues raised by technological change are carefully considered.[1]

[1]Another price index problem in the medical care sector that would be present even if technological change were not rapid is the matter of defining the characteristics and composition of medical care service items.

The purpose of this report is to recommend methods for calculating price indexes required for the specific purpose of a study being conducted by the Urban Institute. That study requires price indexes to decompose the changes in Medicare dollar reimbursements for physicians' services that occur over time and among geographical areas into a price component and a quantity component. The quantity component, which will be stated on a per-enrollee basis, is considered to have two parts -- volume and intensity. Volume per enrollee reflects the rate at which services are utilized by enrollees while intensity is a per-case measure of the (resource) intensiveness with which individual services are rendered.

This report is divided into three sections. The first section addresses the conceptual issues involved in selecting particular price index formulas. The second extends those issues to the needs of time-series analysis and contains recommendations for the formulas to be used. The third serves the same end for cross-sectional analysis.

## Conceptual Issues in Selecting Price Index Formulas

To construct a price index it is first necessary to define its purpose. The Urban Institute requires price indexes to deflate Medicare reimbursements yielding quotients that are themselves indexes of changes in the volume and intensity of services

reimbursed per Medicare enrollee. The volume and intensity changes are to be measured both by type of service and location through time and by type of service across geographical locations at given points in time.

In principle, these uses are typical of those to which price indexes are put. Any of a number of price index formulations are potentially appropriate for use. The choice among them will rest not only on the conceptual relevance of each formulation, but also on how each potential index formula takes into account the rather unique nature of medical care services, the markets through which they are provided and the rapid rate at which the nature of the services changes in response to technological advances and other factors.

The formulas most relevant to the construction of price indexes in this situation are:

1. Laspeyres (L) - a weighted sum of price relatives ($P_1^i/P_0^i$) in which the weights, which are dollar expenditure shares ($w_0^i$), refer to the earlier of the two periods being compared or to the location selected as a base for comparison with other locations.

$$L_{1,0} = \sum w_o^i * \frac{P_1^i}{P_o^i} = \sum \frac{P_o^i Q_o^i}{\Sigma P_o^i Q_o^i} * \frac{P_1^i}{P_o^i} = \frac{\Sigma P_1^i Q_o^i}{\Sigma P_o^i Q_o^i}$$

The foregoing algebra shows how the traditional expression of a Laspeyres index in terms of prices and quantities is equivalent to the expenditure share weighted sum of price relatives.

2. Paasche (P) - a weighted sum of price relatives ($P_o^i/P_1^i$) in which the weights ($w_1^i$), which are dollar expenditure shares, refer to the later of the two periods or to the location other than that selected as the base location.

$$P_{1,0} = \frac{1}{\sum w_1^i * \frac{P_o^i}{P_1^i}} = \frac{1}{\sum \frac{P_1^i Q_1^i}{\Sigma P_1^i Q_1^i} * \frac{P_o^i}{P_1^i}} = \frac{\Sigma P_1^i Q_1^i}{\Sigma P_o^i Q_1^i}$$

3. Fisher's Ideal (FI) - the geometric mean of a Laspeyres and Paasche Index.

$$FI_{1,0} = (L_{1,0} * P_{1,0})^{1/2} = \left( \frac{w_o^i * \frac{P_1^i}{P_o^i}}{w_1^i * \frac{P_o^i}{P_1^i}} \right)^{1/2}$$

4. Tornquist (T) - an exponentially weighted index of price relatives where the weights used are the average dollar expenditure shares for the two periods or two places being compared. This formula is the equivalent of multiplying the weights, after they are averaged, by the

logs of the price relatives, and then summing the products obtained. The log of a price relative is the equivalent of the percentage change in price.

$$\ln T_{1,0} = \sum \frac{(w_o^i + w_1^i)}{2} * \ln \left( \frac{P_1^i}{P_o^i} \right)$$

These indexes are more than merely formulas; each implies different processes or assumptions about the economic relationship between prices and quantities. When comparing prices in two different time periods or locations, the Laspeyres and Paasche indexes each assumes that while there may have been changes in prices between the two situations, the relative quantities produced or purchased did not change. Such an occurrence is rare in practice. Were it to occur, the implication would be that the composition of purchases or sales was not affected by changes in the prices of inputs or outputs. While such assumptions are extreme, they are nonetheless widely used. That is probably because the notion of measuring price change for a fixed market basket of items is fairly easy to grasp and the calculations fairly straight-forward to make. With the L index, data on new weights need only be collected when the weight-base period is changed. Most official government price statistics are calculated from the L formula. Such important analytical tools as input-output tables assume that the proportions of various inputs used to produce a unit of output do not vary with changes in the relative prices of those inputs.

Price index formulas are typically derived from utility functions of consumers or production functions of producers. As a result of their use of fixed weights, Laspeyres or Paasche indexes are the exactly correct price indexes for a rather limited number of production or utility functions. The indexes are exact price indexes only for Leontief-type input-output production or utility functions. While the L and P indexes are nonetheless widely used, note is always taken of the bias that can result from such use. That bias varies to the extent the inputs or outputs for which price indexes are constructed are altered by the relative price changes. And the degree of alteration depends on the form and shape of the production and utility function. For example, because purchasers tend to shift the quantities of items they buy away from those that have become more expensive and toward those that have become less expensive, the Laspeyres index, in a two period or two location comparison, can be shown to be the upper bound of the change in price. Symmetrically, the Paasche index is the lower bound of price change.[2] The true price change would lie between the two.[3] One way to approximate it is through use of the

[2]The relationship between L and P is reversed if the focus of the indexes is switched from consumers to producers. That is because producers will tend to increase the output of those items that have become relatively more expensive.

[3]The notion of a "true" price change requires explanation -- it is the change in the cost of living associated with holding the welfare, or utility, of consumers unchanged as prices change. Because the utility level of consumers is not observable, the true price change cannot be directly estimated. The relationship between L, P and the "true" price index is also dependent on holding the

geometric mean of the two indexes which the economist Irving Fisher termed the "ideal" index. That index is exact for a broader set of production and utility functions and a good approximation to still others. (The latter characteristic is termed "superlative.") Thus, while the FI index has the intuitive appeal of being the average of two bounds, it also has characteristics that permit it to approximate more real economic situations than is possible with L or P.

The Tornquist index is an exact index for an even larger number of economic circumstances. The main disadvantage of the Tornquist index is that while it is also derived as an averaging process, that process is not as transparent because the weights are first averaged before multiplication by the price relatives. In addition, the price relatives are expressed in logs, further obscuring the averaging process that is taking place.

Another consideration in the selection of an index formula is the characteristic of the quantity index that results when price indexes are used to deflate dollar expenditures. Such consideration is particularly important because of the Urban Institute's focus on measuring volumes. (It might be less important if the objective to be served by the price index was

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utility level of consumers unchanged. For example, if utility levels are not held constant, it can no longer be said with certainty that L is greater than the "true" price change which, in turn, is greater than P.

simply to measure medical care inflation.) In the case of an expenditure series deflated by an L price index, the resulting volume index is of a P form. That can be shown as follows:

$$E_{1,0} = \frac{\Sigma P_1^i Q_1^i}{\Sigma P_0^i Q_0^i} = \text{ratio of expenditures}$$

$$L_{1,0} = \frac{\Sigma P_1^i Q_0^i}{\Sigma P_0^i Q_0^i} = \text{Laspeyres price index}$$

$$E_{1,0}/L_{1,0} = \frac{\Sigma P_1^i Q_1^i}{\Sigma P_1^i Q_0^i} = \text{Paasche quantity index}$$

Thus, the volume measure derived using an L price index is the lower bound on the change in output. Conversely, deflating expenditures by a P price index produces a volume measure that will be an upper bound to the quantity index.[4]

The volume measure derived by deflating expenditures by an FI price index is a Fisher's Ideal quantity index. It, of course, has the property in the two period case that it lies between the upper and lower bounds represented by L and P quantity indexes. The fact that the multiplication of an FI price index by an FI quantity index yields an index of total expenditures can be demonstrated as follows:

[4]Note again that the aforementioned relationships are reversed if one moves from a consumption price index to an output price index.

$$F^P_{1,0} = \left( \frac{\Sigma P^1_1 Q^1_0}{\Sigma P^1_0 Q^1_0} * \frac{\Sigma P^1_1 Q^1_1}{\Sigma P^1_0 Q^1_1} \right)^{\frac{1}{2}} = \text{Fisher's Ideal price index}$$

$$F^Q_{1,0} = \left( \frac{\Sigma P^1_0 Q^1_1}{\Sigma P^1_0 Q^1_0} * \frac{\Sigma P^1_1 Q^1_1}{\Sigma P^1_1 Q^1_0} \right)^{\frac{1}{2}} = \text{Fisher's Ideal quantity index}$$

$$F^P_{1,0} * F^Q_{1,0} = \left( \frac{\Sigma P^1_1 Q^1_1}{\Sigma P^1_0 Q^1_0} * \frac{\Sigma P^1_1 Q^1_1}{\Sigma P^1_0 Q^1_0} \right)^{\frac{1}{2}}$$

$$= \frac{\Sigma P^1_1 Q^1_1}{\Sigma P^1_0 Q^1_0} = \text{ratio of expenditures}$$

Another property of price indexes that is relevant to consider is circularity or transitivity. Indexes that have this property provide the ability to compare behavior for more than two time periods or locations and obtain logical results. Circularity assures that an annual price index spanning the period from 1985 to 1988 will provide the result that the multiplication of the annual indexes calculated from each adjacent pair of years equals the same index for 1988 that is obtained by comparing 1988 and 1985 directly. Analogously, if the price indexes were for three cities, then multiplying the ratio of the indexes for city B relative to A by the ratio of C relative to B should yield the same result as that obtained by calculating the ratio of C to A directly.

Unfortunately, none of the price indexes discussed till this point possess the property of circularity.[5]

## Specific Considerations for Time Series Price Indexes

In the preceding section the advantages and disadvantages of various index concepts were presented. The most important practical consideration in the selection of a price index for Medicare reimbursements is the reality that the market basket of medical care services changes rapidly. New technologies quickly replace older ones. The basket can change markedly from one year to the next. Thus, the use of a fixed market basket formula, such as the Laspeyres, could result in bias vis-a-vis what might be termed the "true" price change. The direction of the bias is usually upward as described in the previous section because purchasers are thought to shift away from items that are becoming more expensive and toward items that are becoming less expensive. Analogously, the Paasche index is thought to be the lower bound because it gives a higher weight to the item that has risen less in price than the item that has increased more in price and whose quantity purchased has fallen. However, the bounding conditions ultimately depend on the direction of the correlation between

[5]There are some price index formulas that have the circularity property but they are technically complex and difficult to implement in practice. Further, manipulating an index to achieve circularity leads to the loss of some other desirable properties.

prices and quantities.[6] If they tend to be negatively correlated, L exceeds P. If they tend to be positively correlated, however, P will exceed L. If there is no correlation the two indexes will be the same.[7]

There are two characteristics that attach to the data the Urban Institute will analyze. One clear cut characteristic is that the basket of services undergoes rapid change. Services reflecting older technologies disappear quickly when new ones emerge and the dollar proportions in which services are purchased change quickly. A second characteristic, at this point less well documented, is that the observed correlation between prices and quantities may be positive or zero; that is, the newer technologies that replace older ones, often do so at higher nominal prices.[8] There are two reasons why the observed relationship between quantities and prices

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[6]The correlation between prices and quantities can be zero, negative or positive whether the focus is on quantities consumed or quantities produced.

[7]If expenditure shares ($w^i$) are assumed to remain the same over time, L will be greater than or equal to P because P is an harmonic mean -- i.e., the average of the reciprocals of price relatives -- and is less than or equal to an arithmetic mean, namely, L. However, note that expenditure shares can remain unchanged only if the correlation between prices and quantities is negative or zero. In the latter case, it can be shown that L and P are the same, i.e., the harmonic mean collapses to the arithmetic mean.

[8]After adjustment for the improved quality imbedded in the new technology, the price could be higher or lower than that of the technology being replaced. At this time there continues to be lack of agreement about how to make quality adjustment for medical care services. Thus, when prices of new technologies are linked into indexes, the implicit assumption is that the quality difference is proportional to the price difference.

may be positive or zero. One reason is the practical difficulty of distinguishing between quantities supplied and demanded at different prices. The second reason is that because of the importance of employer provided medical insurance in medical care service purchases, the usual pattern of substitution in response to relative price changes may not be present.

The foregoing characteristics of the market for medical services suggest that fixed weight indexes will be quickly outdated both because the base period market basket will quickly become unrepresentative and because it will become impossible to obtain price data for those items in the base period basket that are no longer available. They also suggest that for medical care services, the usual notion of L as an upper bound and P as a lower bound may not be applicable.

The rapid outdating of weights suggests that weights should be revised frequently. Since the data the Urban Institute will use are annual, it would be possible to introduce new weights annually. Indexes that measure change between a series of pairs of adjacent time periods, years in this case, using weights unique to each pair, result in a series of price indexes for pairs of years which can be chained to measure change over a longer span than two years. Hence, they are termed "chain" indexes.

In the context of this Urban Institute research project, there is the need to measure the rate of change of volume and intensity from 1985 to 1988. If indexes are for pairs of years, they must be chained. Thus,

$L_{86,85} * L_{87,86} * L_{88,87}$ = a chained L from 1985 to 1988.

But such a chained Laspeyres index can no longer be viewed as a bound (upper or lower) on the true price change between 1985 and 1988. The upper bound to the price change between 1985 and 1988 is given by a Laspeyres index that compares 1988 directly to 1985 with 1985 weights. However, the chained Laspeyres index may drift above or below the unchained one. In a symmetrical way, the same problem plagues a chained Paasche. A chained FI, because it is a chain of geometric means of two-period L and P indexes is less likely to drift outside the range of either. (That can also be said about the T index.) Another way to look at this problem is as a circularity issue. If an index measuring change for 1985 to 1986 is multiplied by one for 1986 to 1987, the result will likely differ from that obtained by an index measuring change between 1985 and 1987 directly.

The inability to characterize chain indexes in terms of upper or lower bounds presents a problem of interpretation. For example, if L and P were directly computed for 1988 relative to 1985, it would be possible to fix the limits within which prices had truly

changed between 1985 and 1988. A chain index does not provide any such opportunity for interpretation of price changes. However, it should be noted that in a market with a rapidly changing basket of services, the upper and lower bounds to price changes are very likely to be indeterminable. In other words, a direct comparison between 1985 and 1988 may not be possible because the market basket that was purchased in 1985 may be very different from that purchased in 1988. Therefore, the drift of chain indexes outside their theoretical bounds in a time series context is not a sufficient reason for their rejection as a measure of price change in a market with rapid changes in the basket of services produced and consumed.

Price indexes were compiled by the Urban Institute to illustrate the use of the various price index formulas described above. They were compiled using actual price and weight data for a selection of types of services in a number of geographical areas during the period 1985-88. One set of illustrations involved calculating price indexes for types of services in places where those services were purchased continually during 1985-88. That made it possible to calculate both 1985 weighted and chain-weighted indexes for comparable sets of services. As a result, the effect of using different formulas and changing weights could be observed. The results are shown in Table 1 for services in all areas where the continuous availability of transactions made such calculations possible.

There were an unusually large number of cases where the Paasche index proved to be higher than the Laspeyres. As previously noted, that may be due to the importance of employer provided insurance in medical care service purchases. It may also be the case that the real income of consumers had changed between 1985 and 1988 so as to place them at a higher level of utility.[9] That may also be responsible for the positive relationship observed between prices and quantities.

The FI index lies between L and P in every case, as expected. There was no consistent algebraic sign on the difference between the FI index and the Tornquist. Nor were the absolute differences large. In only three cases were the differences between FI and T 0.5 percent or more over the three year period, but they were never more than 0.7 percent. The T index did lie outside the L-P bound in three cases; two of those were cases in which the L and P relationship was inverted.

In two-thirds of the cases in which there is an L-P inversion, the L chain goes up faster than the 1985 to 1988 L. The P chain drifts below $P_{88,85}$ much less often. Those illustrations are consistent with those of a large number of L-P inversions and suggest the same pattern -- prices and quantities are positively

[9] Recall that the relationship between L, P and the "true" index level depends upon an unchanged level of utility (see footnote 3.)

TABLE 1: Illustrative Calculations of Alternative Price Indexes, 1985-88

| | Procedure | Area | L | P | FI | T | L chain | P chain | FI chain | T chain |
|---|---|---|---|---|---|---|---|---|---|---|
| I1 | Standard Imaging | Rural AL | 1.1312 | 1.1217 | 1.1264 | 1.1267 | 1.1288 | 1.1255 | 1.1272 | 1.1272 |
| | | Rural KY | 1.0467 | 1.0469 | 1.0468 | 1.0470 | 1.0415 | 1.0439 | 1.0427 | 1.0425 |
| | | NYC Sub/LI | 1.2869 | 1.2684 | 1.2776 | 1.2775 | 1.2861 | 1.2850 | 1.2856 | 1.2812 |
| | | Rural PA | 1.2228 | 1.2089 | 1.2158 | 1.2157 | 1.2206 | 1.2148 | 1.2177 | 1.2176 |
| | | Tennessee | 1.1151 | 1.1096 | 1.1123 | 1.1122 | 1.1128 | 1.1106 | 1.1117 | 1.1117 |
| M1 | Office Visits | Rural AL | 1.2036 | 1.2102 | 1.2069 | 1.2066 | 1.2038 | 1.2037 | 1.2037 | 1.2037 |
| | | N/NC FL Cities | 1.2159 | 1.2181 | 1.2170 | 1.2166 | 1.2246 | 1.2194 | 1.2220 | 1.2220 |
| | | Rural KY | 1.0840 | 1.0932 | 1.0886 | 1.0885 | 1.0906 | 1.0935 | 1.0921 | 1.0920 |
| | | NYC Sub/LI | 1.1305 | 1.1269 | 1.1287 | 1.1287 | 1.1291 | 1.1278 | 1.1285 | 1.1285 |
| | | Rural PA | 1.2187 | 1.2217 | 1.2202 | 1.2202 | 1.2192 | 1.2198 | 1.2195 | 1.2195 |
| | | Tennessee | 1.2242 | 1.2299 | 1.2270 | 1.2270 | 1.2305 | 1.2305 | 1.2305 | 1.2307 |
| M4 | Non Hosp, Non Spec Visits | Rural AL | 1.1132 | 1.1086 | 1.1109 | 1.1118 | 1.1126 | 1.0942 | 1.1034 | 1.1034 |
| | | N/NC FL Cities | 1.1679 | 1.1732 | 1.1705 | 1.1707 | 1.1693 | 1.1674 | 1.1684 | 1.1684 |
| | | Rural KY | 1.1730 | 1.1959 | 1.1844 | 1.1846 | 1.1785 | 1.1937 | 1.1861 | 1.1861 |
| | | NYC Sub/LI | 1.1341 | 1.1424 | 1.1382 | 1.1383 | 1.1339 | 1.1392 | 1.1366 | 1.1366 |
| | | Rural PA | 1.1989 | 1.1898 | 1.1943 | 1.1942 | 1.1910 | 1.1896 | 1.1903 | 1.1904 |
| M5 | Specialist Eval & Mgt Services | Rural AL | 1.0392 | 1.0353 | 1.0372 | 1.0376 | 1.0319 | 1.0251 | 1.0285 | 1.0285 |
| | | N/NC FL Cities | 1.1905 | 1.2466 | 1.2182 | 1.2227 | 1.2127 | 1.2399 | 1.2262 | 1.2295 |
| | | Rural KY | 1.1023 | 1.0299 | 1.0655 | 1.0592 | 1.0718 | 0.9807 | 1.0253 | 1.0212 |
| | | Rural PA | 1.2664 | 1.2731 | 1.2697 | 1.2766 | 1.2387 | 1.2340 | 1.2363 | 1.2365 |
| | | Tennessee | 1.0702 | 1.0683 | 1.0692 | 1.0693 | 1.0732 | 1.0701 | 1.0717 | 1.0718 |
| P1C | Cardiovascular Procedures | N/NC FL Cities | 1.1350 | 1.1451 | 1.1400 | 1.1410 | 1.1272 | 1.1295 | 1.1284 | 1.1289 |
| | | Tennessee | 1.0840 | 1.0953 | 1.0896 | 1.0868 | 1.1036 | 1.0963 | 1.1000 | 1.1004 |

correlated in the underlying data. The FI chain is always between the L chain and P chain. It does, however, sometimes fall outside the L-P bounds, but there is no prior condition affecting the relationship between an FI chain and the L-P range for indexes covering three or more time periods.

The difference in movement between FI chain and T chain is not consistently in one direction or another. And regardless of their direction, the differences are quite small.

These illustrations support the a priori rationale for the use of the Fisher's Ideal and Tornquist indexes for deriving volume and intensity changes for physicians' services. That is because they do not use weights of one specific year. The importance of that property is especially evident in the large number of Laspeyres and Paasche inversions.

While the L-P bounding conditions are not necessarily relevant to cases in which quantity levels are changing rapidly, more credibility probably attaches to the Fisher or Tornquist outcomes. That is because it seems reasonable that if two sets of weights yield price indexes with important differences, it is best to use their average. As between the Fisher and the Tornquist, the former has the desirable property, shown earlier (page 9), that the quantity index derived by using the FI price index as a deflator is also a Fisher's Ideal index. As noted, the quantity index

resulting from the use of a T index cannot be specifically characterized. Thus, a priori support for using an FI index is not inconsistent with the anecdotal evidence from the illustrative index calculations.

The next question is whether or not the FI itself should be chained. A second set of cases has been designed to illustrate this issue. This second set of experimental calculations, found in Table 2, permits analysis between both chained and unchained indexes that span 1985-88 and consist only of items common to all years (i.e., there are price observations for both end points) and those that appear in the end-point years only. Those indexes based on items for which prices are available in every year are found in rows marked Y(es); if there are some discontinuities in the price series, the resulting indexes are found in rows marked N(o). Indexes both spanning the entire 1985-88 period and those developed from chaining each year-to-year index are also calculated. All four formulas -- L, P, FI and T -- are utilized. The chained indexes in the Table are based on all continuously available prices (Y) and on those observations available between each pair of years (N).

Chained indexes can also be calculated from the data using all pairable observations.

TABLE 2: Illustrative Calculations for Alternative Price Indexes, 1985-88

| | Procedure | Area | Common to all years | L | P | FI | T | L chain | P chain | FI chain | T chain |
|---|---|---|---|---|---|---|---|---|---|---|---|
| I2 | Advanced Imaging | Rural AL | Y | 0.9474 | 0.9676 | 0.9574 | 0.9577 | 0.9508 | 0.9600 | 0.9554 | 0.9528 |
| | | | N | 0.9401 | 0.9673 | 0.9536 | 0.9508 | 0.9515 | 0.9614 | 0.9564 | 0.9537 |
| | | N/NC FL Cities | Y | 1.1492 | 1.1705 | 1.1598 | 1.1603 | 1.1332 | 1.1449 | 1.1390 | 1.1419 |
| | | | N | 1.1492 | 1.1705 | 1.1598 | 1.1603 | 1.1274 | 1.1379 | 1.1326 | 1.1353 |
| | | Rural KY | Y | 1.2219 | 1.2422 | 1.2320 | 1.2338 | 1.2045 | 1.2291 | 1.2167 | 1.2163 |
| | | | N | 1.2219 | 1.2422 | 1.2320 | 1.2338 | 1.1932 | 1.2263 | 1.2096 | 1.2082 |
| | | Detroit | Y | 1.3023 | 1.3031 | 1.3027 | 1.3033 | 1.3132 | 1.3155 | 1.3144 | 1.3150 |
| | | | N | 1.3023 | 1.3031 | 1.3027 | 1.3033 | 1.3060 | 1.3016 | 1.3038 | 1.3056 |
| | | Tennessee | Y | 1.2391 | 1.2157 | 1.2273 | 1.2283 | 1.2328 | 1.2267 | 1.2298 | 1.2302 |
| | | | N | 1.2391 | 1.2157 | 1.2273 | 1.2283 | 1.2329 | 1.2267 | 1.2298 | 1.2304 |
| I4 | Imaging/Procedures | Rural AL | Y | 1.2158 | 1.2089 | 1.2123 | 1.2136 | 1.2052 | 1.2078 | 1.2065 | 1.2066 |
| | | | N | 1.2158 | 1.2089 | 1.2123 | 1.2136 | 1.2048 | 1.2074 | 1.2061 | 1.2062 |
| | | N/NC FL Cities | Y | 1.2363 | 1.2386 | 1.2374 | 1.2375 | 1.2357 | 1.2373 | 1.2365 | 1.2365 |
| | | | N | 1.2363 | 1.2386 | 1.2374 | 1.2375 | 1.2363 | 1.2401 | 1.2382 | 1.2384 |
| | | Rural KY | Y | 1.1257 | 1.1091 | 1.1174 | 1.1184 | 1.0825 | 1.1878 | 1.1339 | 1.1278 |
| | | | N | 1.1198 | 1.1066 | 1.1132 | 1.1139 | 1.0825 | 1.1878 | 1.1339 | 1.1278 |
| | | Detroit | Y | 1.0235 | 1.1266 | 1.0738 | 1.0204 | 1.0012 | 1.0486 | 1.0246 | 0.9996 |
| | | | N | 1.0235 | 1.1266 | 1.0738 | 1.0204 | 1.0003 | 1.0464 | 1.0231 | 0.9981 |
| | | Tennessee | Y | 1.1712 | 1.1483 | 1.1597 | 1.1584 | 1.1577 | 1.1494 | 1.1535 | 1.1536 |
| | | | N | 1.1712 | 1.1483 | 1.1597 | 1.1584 | 1.1576 | 1.1474 | 1.1525 | 1.1527 |
| T2 | Non Lab Tests | Rural AL | Y | 1.1820 | 1.1910 | 1.1865 | 1.1876 | 1.1898 | 1.1961 | 1.1929 | 1.1952 |
| | | | N | 1.1820 | 1.1910 | 1.1865 | 1.1876 | 1.2209 | 1.1825 | 1.2016 | 1.2026 |
| | | N/NC FL Cities | Y | 1.1940 | 1.1946 | 1.1943 | 1.1946 | 1.1965 | 1.1957 | 1.1961 | 1.1961 |
| | | | N | 1.1940 | 1.1946 | 1.1943 | 1.1946 | 1.1983 | 1.1971 | 1.1977 | 1.1978 |
| | | Rural KY | Y | 1.1736 | 1.1576 | 1.1656 | 1.1670 | 1.1962 | 1.1364 | 1.1659 | 1.1666 |
| | | | N | 1.1736 | 1.1576 | 1.1656 | 1.1670 | 1.1592 | 1.1103 | 1.1345 | 1.1358 |
| | | Detroit | Y | 1.0722 | 1.0526 | 1.0624 | 1.0557 | 1.0777 | 1.0304 | 1.0538 | 1.0570 |
| | | | N | 1.0722 | 1.0526 | 1.0624 | 1.0557 | 1.0987 | 1.0668 | 1.0826 | 1.0872 |

For the unchained indexes, it appears to make little difference whether the 1985 to 1988 price change is measured using items that are purchased only in the terminal years or in every year. That finding reflects the fact that if an item was purchased both in 1985 and three years later, in 1988, it was probably bought in each intervening year. So virtually the same sets of prices and weights are being used.

The chained indexes show a large variance or divergence, depending on whether the price set is the larger one consisting of all items purchased in every adjacent pair of years or the smaller one. Thus, there is clearly additional information that is incorporated in chained indexes.

The recommendations that emerge from review of the concepts of the various price index formulas and their application to time-series measurement, together with review of the illustrative data in the two tables are:

1. use the Fisher's Ideal Index and
2. use it in the chain form.

The chained FI copes most effectively with situations in which there are substantial weight and item variations over time. Also, the nature of the volume and intensity indexes resulting from an FI index are clearly visible -- they, too, are FI indexes.

## Specific Considerations for Place-to-Place Price Indexes

The same issues that enter into the selection of time series index formulas are relevant to cross-section index selection. But the considerations associated with each selection criterion are different. The issue of establishment and maintenance of a base weight involves different considerations. There is probably more reason to want to compare volume and intensity per enrollee in each area with that of the U.S. national average than to compare volume and intensity in the various years based on a fixed basket for any one year. Yet it is also clear that the composition of services purchased in any one locality can differ substantially from the national average. Thus, the choice of weights remains a problem, but clearly the need arises to select a relevant comparator for inter-area comparisons.

The index issue that takes on more importance in a cross-section context than in a time series one is the characteristic of circularity. It was of some importance in a time-series context to be sure, primarily because chained time series indexes could lie outside P and L bounds. The analogous cross-section issue is that the index measuring price changes from New York to Los Angeles

could be different from the product of the indexes from New York to Chicago and from Chicago to Los Angeles.[10]

With the consideration of appropriate weights and the issue of circularity, the specific needs of the project need to be addressed. The Urban Institute needs to measure differences in the volume and intensity of physicians' services rendered per enrollee in various U.S. geographical areas. Analysis of the data used to compile the illustrative indexes presented in Tables 1 and 2 was not inconsistent with the a priori view that the basket of services purchased varies considerably across space. In any given year not all items are purchased in all places. And it has been shown (Table 2 cases) that there are important differences between indexes calculated from all observations common to each pair of years as compared with indexes using a set of items common to all years. Additionally, there appear to be large differences in the proportion of spending on items across areas, even if they are purchased in many areas.

The foregoing view of the time series issues are relevant as well for cross-section indexes. Therefore, to measure cross-

[10]In the time-series context, it was noted that a direct comparison between 1985 and 1988 need not yield the same result as a comparison based on the chaining of annual indexes between 1985 and 1988. However, it was also noted that a direct comparison between 1985 and 1988 may not be feasible. In a cross-section context, a direct comparison may be feasible for a number of cities. Therefore, circularity is a more important issue in a cross-section context.

section volume differences, the use of the FI formula is also recommended. The Paasche component of the FI should be formed by using the weights of the items purchased in each particular place, expressed in expenditure share form. Those expenditure weights should be used to aggregate price relatives consisting of the national average price in the numerator and the locality price in the denominator. The invese of that weighted aggregate of price relatives will yield the Paasche index for the prices in each locality relative to the set of average national prices. The Laspeyres component of the FI should contain national weights expressed as expenditure shares, but only for those items also bought in the locale for which the comparison is being made. The FI would then be derived, of course, as the geometric mean of the L and P. It should be noted that the "numeraire" for a particular locale will not necessarily be the same national market basket as for another locale.

Comparing a locale's expenditures per enrollee deflated by such an FI with deflated average national expenditures per enrollee on the same items would answer the question "What is the difference between the volume of purchases in place "i" and the volume of the same services purchased by the average enrollee in the nation as a whole?" The volume level difference, so obtained, would be an FI quantity index, like its time-to-time counterpart. Thus, all volume measures, time series and cross section, would be derived from comparable methodologies.

In those cases in which the same items are purchased in two or more locales a caveat is, of course, in order regarding the property of circularity lacking in the FI. That means that if medical care in Kansas City were less expensive than in the nation as a whole and the latter less expensive than Chicago, a Fisher's Ideal that compares Kansas City and Chicago directly could show the former to be more expensive than the latter. The volume level comparisons derived will have the same shortcoming. However, because the numeraire is the nation - and all comparisons are to the nation - the absence of circularity is relatively unimportant for the purpose for which the index will be used. There are more complex price index formulas that approach having the property of circularity. However, they are quite complicated to implement. For the purposes for which the Urban Institute will use these volume-level comparisons, it seems unnecessary to complicate the calculations. The lack of circularity can be addressed by careful description of what the volume and intensity measures represent. Thus, any table showing the cost or volume of medical care per enrollee in various cities compared with the per enrollee national average, should carry a footnote warning about drawing inferences about the relative ranking of any two cities. That caveat would apply not only to cities that purchase the same items, but also to those which do not. For the latter group, comparisons among locales are meaningless. That is because of the incomparability of the list of items in the market basket of each.

The FI output comparisons, derived by using the FI price indexes, will probably show correctly, that "health center" cities, because they provide newer and probably more costly services, have higher output levels vis-a-vis the US market baskets to which they are compared. The extent of the higher volume attributed to the availability of the latest services in such cities could be evaluated with some precision if another set of volume comparisons were calculated. For that set, the FI price indexes would be based only on a set of services common to all locales (the same spatial notion incorporated in one of the time series measures in Table 2). The resulting volume level measure would then provide a comparison between the volume of each locale's purchases of the set of services purchased everywhere and the average national volume per enrollee of a basket of the same services. The difference, then, between that comparison and the comparison of local to national volumes in which the P part of the FI is based on the locale's set of services would be an indicator of how much of the locale's volume consists of services not available and/or used widely elsewhere. The difference would be only an indicator, however, not a precise measure. One major reason is that in the "common to all" basket, a rural area may appear to consume relatively more because it is forced to use more of a less technically advanced service for which no replacement is available in the rural area. Thus, the degree of substitution and complimentarity of services can affect the difference in volumes observed when comparing the two measures.

While that surely is a shortcoming, the "common-to-all" basket may have a role in explaining the actual total volume level differences in pairwise comparisons of all services between each locale and the national average.

# APPENDIX B

## Designation of
## Medicare Payment Localities

APPENDIX B

Designation of Madicare Paymant Localities

VERY LARGE CITIES

San Francisco, Cal matro area
Washington, DC metro area
Miami, Fla
Chicago, Ill
Urban Mass
Datroit, Mich
NYC metro area
Larga cities, Penn
Houston, Tex
Los Angelas, Cal

ADJACENT LARGE CITIES

Oakland/Berkeley, Cal
San Barnadino/Riversida, Cal
Fort Laudardale, Fla
East St. Louis, Ill
Poughkpsie/North NYC suburbs
Ventura, Cal
Anahaim/Santa Ana, Cal

NONADJACENT LARGE CITIES

Birmingham, Ala
New Orleans, La
Sacremento, Cal
Santa Clara/Monterey, Cal
North and North Central Fla
Indiana metro araas
Kansas City matro araa
Buffalo, NY
Rochastar, NY
San Antonio, Tax
Dallas, Tax
Seattle, Wash
Milwaukee, Wisc
Phoenix, Ariz
Atlanta, Ga
Portland, Ore
San Diego, Cal
Hartford, Conn
New Haven, Conn
St. Paul/Minnaapolis, Minn
Tidewatar, Va
St. Louis, Mo
Akron/Youngstown, Ohio
Cincinnati, Ohio
Cleveland, Ohio
Columbus, Ohio
Dayton/Springfield, Ohio
Baltimora, MD

SMALL CITIES

Small citias, Ala
Mobila, Ala
Small citias, La
Stockton, Cal
Mercad, Cal
Fresno, Cal
Montaray, Cal
Bakarsfiald, Cal
Small cities, Ill
Small cities, Ind
Iowa City, Iowa
Omaha, Neb
Lexington/Louisville, Ky
N. Central cities, NY
Small cities, Pann
Fort Worth, Tex
Tucson, Ariz
Small citias, Ga
Oklahoma City, Ok
Tulsa, Ok
Santa Barbara, Cal
Stamford, Conn
Richmond, Va
Charleston, Wv

SMALL CITIES/RURAL

Small citias/rural Iowa
Small cities/rural Kan
Small cities/rural Neb
Small cities/rural Ky
Small cities/rural Mass
Small cities/rural Mich
Small cities/rural Minn
Northeast Tax
Southeast Tex
Western Tex
Small cities/rural Wash
Small citias/rural Wisc
Small cities/rural Ore
Small cities/rural Conn
Small cities/rural Va
Small cities/rural Mo
Small cities/rural Ohio
Small cities/rural WV
Small cities/rural MD

RURAL

Rural Ala
Rural La
Northern Rural Cal
Rural Fla
Rural Ill
Rural Ind
Rural NY
Rural Penn
Rural Ariz
Rural Ga
Rural Ok

STATEWIDE

Arkansas
Colorado
Dalaware
Montana
New Hampshire
Varmont
North Dakota
South Dakota
New Jersey
Rhode Island
South Carolina
Utah
Alaska
Hawaii
Navada
New Mexico
Idaho
Tennassaa
Wyoming
North Carolina
Mississippi
Maine

# APPENDIX C

## Geographic Differentials in Price for Medicare Physician Services, by Area and Area Type, 1988

APPENDIX C

Geographic Differentials in Price for Medicare Physician Services, by Area and Area Type, 1988

| Medicare Carrier | Area Name | Area-Level Fisher's Ideal Index |
|---|---|---|
| **VERY LARGE CITIES** | | |
| 00542 | San Francisco/San Mateo/Marin, CA | 1.155 |
| 00580 | DC and MD/VA Suburbs (Area Wide) | 1.149 |
| 00590 | Miami, FL | 1.317 |
| 00621 | Chicago, IL | 1.084 |
| 00700 | Urban Massachusetts | 1.095 |
| 00710 | Detroit, MI | 1.017 |
| 00803 | New York City Metro | 1.310 |
| 00865 | Large Cities Pennsylvania | 1.064 |
| 00900 | Houston, TX | 1.098 |
| 02050 | Los Angeles, CA | 1.337 |
| **LARGE CITIES - ADJACENT** | | |
| 00542 | Oakland/Berkeley, CA | 1.556 |
| 00542 | San Bernadino/Riverside, CA | 1.212 |
| 00590 | Fort Lauderdale, FL | 1.167 |
| 00621 | East St. Louis, IL | 0.904 |
| 00803 | Poughkpsie/N NYC Suburbs | 1.078 |
| 02050 | Ventura, CA | 1.283 |
| 02050 | Anaheim/Santa Ana, CA | 1.263 |
| **LARGE CITIES - NONADJACENT** | | |
| 00510 | Birmingham, AL | 0.966 |
| 00528 | New Orleans, LA | 1.037 |
| 00542 | Sacramento, CA | 1.121 |
| 00542 | Santa Clara/Monterey, CA | 1.154 |
| 00590 | N/NC Florida Cities | 1.035 |
| 00630 | Metropolitan Indiana | 0.916 |
| 00690 | Baltimore, MD | 1.097 |
| 00740 | Kansas City (Area Wide) | 0.941 |
| 00801 | Buffalo, NY | 0.958 |
| 00801 | Rochester, NY | 0.957 |
| 00900 | San Antonio, TX | 1.073 |
| 00900 | Dallas, TX | 1.094 |
| 00930 | Seattle, WA | 0.959 |

| Medicare Carrier | Area Name | Area-Level Fisher's Ideal Index |
|---|---|---|
| **LARGE CITIES - NONADJACENT** (continued) | | |
| 00951 | Milwaukee, WI | 0.953 |
| 01030 | Phoenix, AZ | 1.086 |
| 01040 | Atlanta, GA | 0.963 |
| 01380 | Portland, OR | 0.949 |
| 02050 | San Diego, CA | 1.255 |
| 10230 | Hartford, CT | 1.004 |
| 10230 | New Haven, CT | 1.070 |
| 10240 | St. Paul/Minneapolis, MN | 0.905 |
| 10490 | Tidewater, VA | 0.931 |
| 11260 | St. Louis, MO | 0.906 |
| 16360 | Akron/Youngstown, OH | 0.983 |
| 16360 | Cincinnati, OH | 0.971 |
| 16360 | Cleveland, OH | 1.077 |
| 16360 | Columbus, OH | 1.005 |
| 16360 | Dayton/Springfield, OH | 0.971 |
| **SMALL CITIES** | | |
| 00510 | Small Cities Alabama | 0.893 |
| 00510 | Mobile, AL | 0.873 |
| 00528 | Small Cities Louisiana | 0.956 |
| 00542 | Stockton, CA | 1.146 |
| 00542 | Merced, CA | 1.139 |
| 00542 | Fresno, CA | 1.120 |
| 00542 | Monterey, CA | 1.107 |
| 00542 | Bakersfield, CA | 1.196 |
| 00621 | Small Cities Illinois | 0.880 |
| 00630 | Small Cities Indiana | 0.835 |
| 00640 | Iowa City, IA | 0.911 |
| 00655 | Omaha, NB | 0.929 |
| 00660 | Lexington/Louisville, KY | 0.937 |
| 00801 | N Central Cities New York | 0.955 |
| 00865 | Small Cities Pennsylvania | 0.989 |
| 00900 | Fort Worth, TX | 1.002 |
| 01030 | Tucson, AZ | 1.032 |
| 01040 | Small Cities Georgia | 0.946 |
| 01370 | Oklahoma City, OK | 0.924 |
| 01370 | Tulsa, OK | 0.932 |
| 02050 | Santa Barbara, CA | 1.263 |
| 10120 | Stamford, CT | 1.144 |
| 10490 | Richmond, VA | 0.926 |
| 16510 | Charleston, WV | 1.029 |

APPENDIX C
(continued)

| Medicare Carrier | Area Name | Area-Level Fisher's Ideal Index |
|---|---|---|
| **SMALL CITIES/RURAL** | | |
| 00640 | Small Cities/Rural Iowa | 0.848 |
| 00650 | Small Cities/Rural Kansas | 0.960 |
| 00655 | Small Cities/Rural Nebraska | 0.785 |
| 00660 | Small Cities/Rural Kentucky | 0.885 |
| 00690 | Small Cities/Rural Maryland | 0.961 |
| 00700 | Small Cities/Rural Massachusetts | 1.023 |
| 00710 | Small Cities/Rural Michigan | 0.923 |
| 00720 | Small Cities/Rural Minnesota | 0.795 |
| 00900 | Northeast Texas | 0.986 |
| 00900 | Southeast Texas | 1.022 |
| 00900 | Western Texas | 0.976 |
| 00930 | Small Cities/Rural Washington | 0.973 |
| 00951 | Small Cities/Rural Wisconsin | 0.846 |
| 01380 | Small Cities/Rural Oregon | 0.927 |
| 10230 | Small Cities/Rural Connecticut | 0.987 |
| 10490 | Small Cities/Rural Virginia | 0.816 |
| 11260 | Small Cities/Rural Missouri | 0.800 |
| 16360 | Small Cities/Rural Ohio | 0.950 |
| 16510 | Small Cities/Rural West Virginia | 0.963 |
| **RURAL** | | |
| 00510 | Rural Alabama | 0.835 |
| 00528 | Rural Louisiana | 0.909 |
| 00542 | Northern Rural California | 1.100 |
| 00590 | Rural Florida | 1.014 |
| 00621 | Rural Illinois | 0.883 |
| 00630 | Rural Indiana | 0.816 |
| 00801 | Rural New York | 0.907 |
| 00865 | Rural Pennsylvania | 0.921 |
| 01030 | Rural Arizona | 1.035 |
| 01040 | Rural Georgia | 0.880 |
| 01370 | Rural Oklahoma | 0.840 |
| **STATEWIDE** | | |
| 00520 | Arkansas | 0.921 |
| 00550 | Colorado | 0.806 |
| 00570 | Delaware | 0.999 |
| 00751 | Montana | 0.899 |
| 00780 | New Hampshire | 0.885 |
| 00780 | Vermont | 0.924 |
| 00820 | North Dakota | 0.928 |
| 00820 | South Dakota | 0.860 |

APPENDIX C
(continued)

| Medicare Carrier | Area Name | Area-Level Fisher's Ideal Index |
|---|---|---|
| **STATEWIDE** (continued) | | |
| 00860 | New Jersey | 1.034 |
| 00870 | Rhode Island | 0.993 |
| 00880 | South Carolina | 0.829 |
| 00910 | Utah | 0.837 |
| 01020 | Alaska | 1.305 |
| 01120 | Hawaii | 1.174 |
| 01290 | Nevada | 1.252 |
| 01360 | New Mexico | 1.009 |
| 05130 | Idaho | 0.830 |
| 05440 | Tennessee | 0.871 |
| 05530 | Wyoming | 0.850 |
| 05535 | North Carolina | 0.870 |
| 10250 | Mississippi | 0.802 |
| 21200 | Maine | 0.892 |

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